



L-Università
ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2025 MAIN SESSION**

SUBJECT: **Chemistry**
 PAPER NUMBER: I – Level 1-2-3
 DATE: 22nd May 2025
 DURATION: 2 hours 5 minutes

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = $0 \text{ }^\circ\text{C}$ and 10^5 Pa /1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- The following information is printed on the back of this booklet:
 - Periodic Table.
 - Reactivity Series.
 - Order of discharge at electrodes.
 - List of polyatomic ions and their charges.
 - Solubility rules.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	11	Total
Score												
Maximum	7	9	10	10	12	12	7	11	10	5	7	100

Answer ALL questions.

1.
 a. Many solid carbonates react with acids to produce carbon dioxide as one of the products. Complete the missing substances in the following word equation.



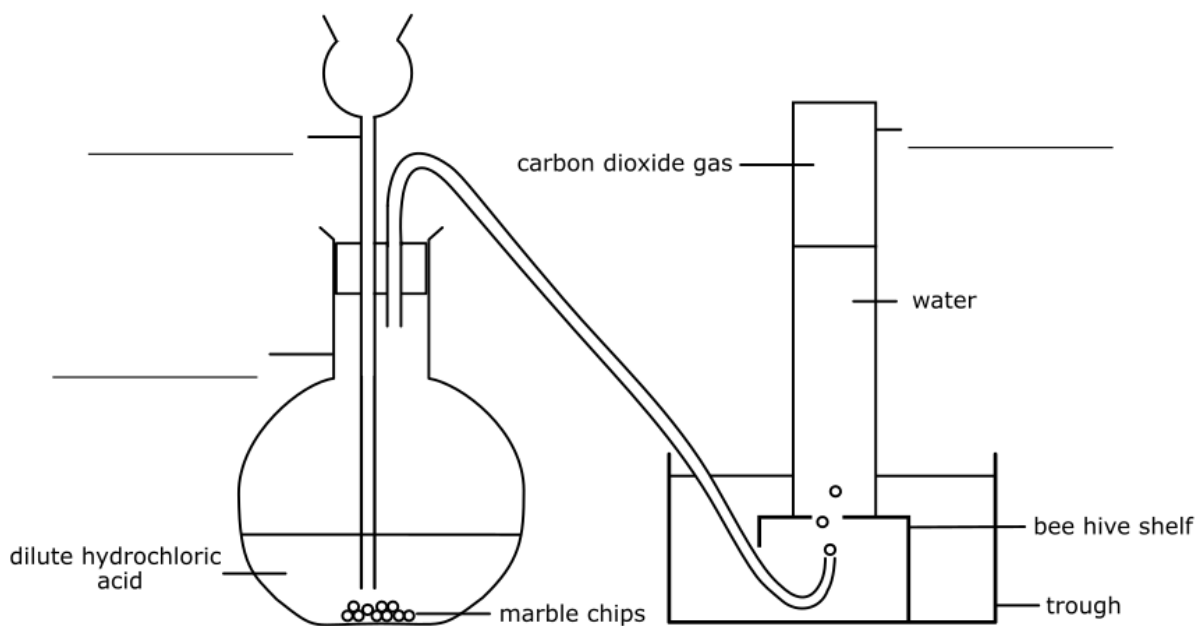
Substance S: _____ (1)

Substance T: _____ (1)

- b.
 i. The reaction in part (a) may be carried out in a test tube. Two small pieces of moist red and moist blue litmus papers are placed across the mouth of the test tube. Given that carbon dioxide is weakly acidic which **ONE** of the two litmus papers will change colour?

_____ (1)

- ii. Label the following diagram of the apparatus setup that is used to collect carbon dioxide.



Source: dsvp.mt/subjects/chemistry (3)

- c. Describe briefly a chemical test including the expected result to prove the presence of carbon dioxide.

_____ (1)

(Total: 7 marks)

2. Rock salt is **not** pure since it also contains some solid impurities which are **not** soluble in water.
 a. A group of students are asked to prepare pure crystals of salt (sodium chloride) starting from rock salt. Table 1 below shows some of the steps of the procedure. Complete Table 1 by filling in the missing steps. (2)

Table 1


Steps to be followed	Description
Step 1	Take two spatulas of chunky rock salt and crush into smaller pieces.
Step 2	Half fill a small beaker with distilled water, add the rock salt pieces from step 1 and stir well.
Step 3	
Step 4	
Step 5	Evaporate the water to obtain salt crystals.

b. How can the chunky rock salt be crushed safely?
 _____ (1)

c. In step 2, what can be observed happening in the beaker while the contents are being stirred? State **TWO** observations.

 _____ (2)

d. How does the experiment show that rock salt contains insoluble impurities?
 _____ (1)

e. Draw a labelled diagram to show how step 5 is carried out.
 (3)

(Total: 9 marks)

3. a. Two students are to prepare and collect a sample of dry lead(II) chloride. The students are provided with: lead(II) sulfate, lead(II) nitrate, hydrochloric acid, potassium chloride, and silver chloride.

From the above, which are the **TWO** correct starting materials for the experiment? Reference may be made to the solubility rules at the end of the examination paper.

Substance 1: _____ (1)

Substance 2: _____ (1)

b. Give a balanced equation for the reaction in part (a).
 _____ (2)

c. Describe in detail how the experiment is carried out and how a dry sample of lead(II) chloride is obtained.

(6)
(Total: 10 marks)

4. This question is about the effect of an electric current on different substances to determine whether they are electrolytes or non-electrolytes.
You have two substances, lead(II) bromide and ethanol.

- a.
- i. Draw a labelled circuit diagram that can be used to study the effect of an electric current on molten lead(II) bromide.

(4)

ii. How can the circuit in part (a) (i) be modified to study the effect of an electric current on ethanol?

(1)

iii. Fill in the expected observations from the experiments in part (a) (i) and part (a) (ii) in Table 2 below.

(3)

Table 2

Experiment	Substance	Observations
Part (a) (i)	molten lead(II) bromide	
Part (a) (ii)	ethanol	

- c. From the results of the experiment state the order of reactivity of these three Group 7 elements in ascending order.

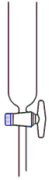


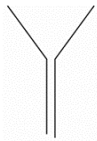
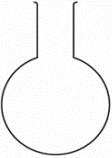

(1)

(Total: 12 marks)

6.

- a. Table 3 shows various items of apparatus that are used often in the laboratory. Write the name of each in the spaces provided. (6)

Table 3

Picture	Name
	
	
	
	
	
	

- b. The students need to prepare a standard solution of sodium carbonate. They have been given the following steps as shown in Table 4, but these are **not** in the correct order.

Table 4

Step	Instruction
A	Top up with distilled water to the mark.
B	Weigh solid in the watch glass.
C	Transfer to an accurate flask quantitatively / without losing any.
D	Transfer to a small beaker + stir.

i. State the correct order of the steps to be followed, using the letters indicated in the first column.

_____ (3)

ii. Why must the contents in step A be well shaken?

_____ (1)

iii. State **TWO** experimental precautions to ensure the preparation of an accurate standard solution.

 _____ (2)

(Total: 12 marks)

7. The word bank below shows some suggestions to protect different types of objects against rusting. Cover with a plastic sheet, store under oil, and dip in molten wax

grease	vacuum chamber	cover with paper	galvanise	paint
--------	----------------	------------------	-----------	-------

Not all of the suggestions are suitable anti-rusting methods. Choose an appropriate rust protection method from the word bank above for each of the situations in Table 5 below.

Table 5

a.	an iron window frame in a house	
b.	iron coins as collectors' items	
c.	the metal parts of a fan	
d.	an iron balcony in a coastal building	
e.	the moving parts of a motorcycle that is not going to be used for quite some time	
f.	as a short-term protection when the paint on the side of a car has a deep scratch	
g.	iron supports under an outdoor air conditioning unit	

(Total: 7 marks)

Please turn the page.

- 8.
- a. When substances are heated several changes occur, **not** all of which are visible. Figure 1 below represents the effect of heat on pure water. Interpret the following graph mentioning what is happening in terms of the heat supplied and the temperature changes, if any, recorded during stages A to E.

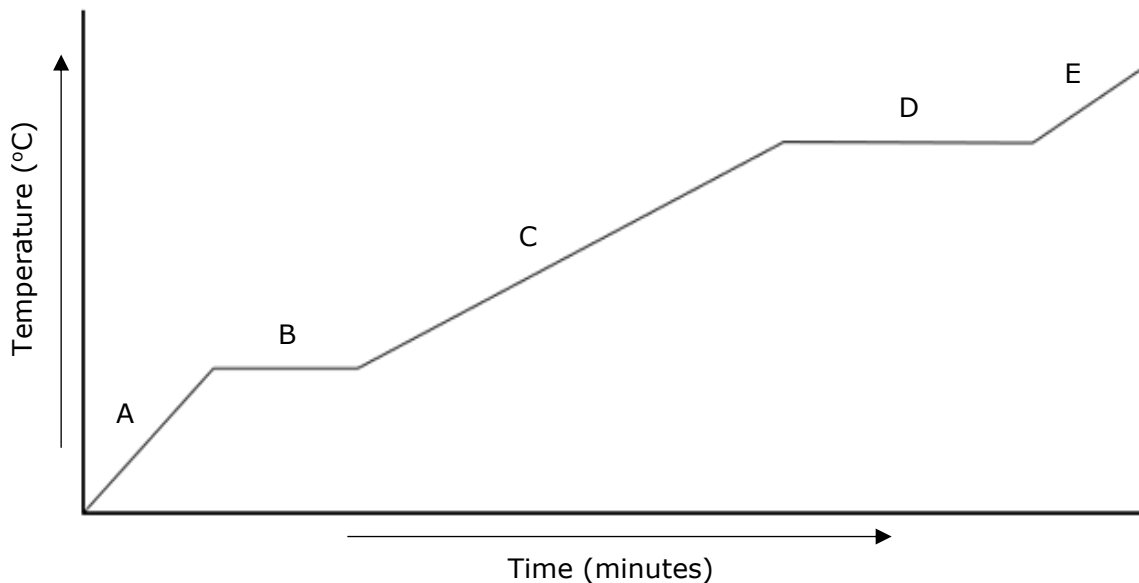


Figure 1: Heating curve of pure water

(5)

- b. The graph consists of five parts represented as **A, B, C, D,** and **E.**
- i. Label the states of matter shown by letters **A,** and **E.**
- A:** _____, **E:** _____ (2)
- ii. What is the temperature at parts **B** and **D**?
- Temperature at **B:** _____, temperature at **D:** _____ (2)
- iii. Explain **TWO** differences between the particles in part **A** of the graph and the particles in part **E** of the graph.

(2)

(Total: 11 marks)

9. A group of students need to determine the empirical formula of copper(II) oxide by experiment. They are provided with some copper turnings and a crucible as well as any other laboratory apparatus that may be required.

a.

i. Describe how the experiment should be carried out.

(5)

ii. Give **ONE** safety consideration for this experiment.

(1)

b. In the experiment 7.93 g of copper turnings were used. After the experiment 9.94 g of copper(II) oxide were obtained. Calculate the empirical formula of copper(II) oxide.

(4)

(Total: 10 marks)

10. The rate of a reaction depends on several factors. One factor is the surface area of the reactants.

Two groups of students investigate the rate of reaction between dilute hydrochloric acid and barium carbonate.

The groups used the quantities as indicated below, carrying out the experiment in a conical flask and recording the volume of the gas produced at particular time intervals.

Group 1	Group 2
5 g chunky barium carbonate	5 g powdered barium carbonate
50 cm ³ 1.0 mol dm ⁻³ HCl	50 cm ³ 1.0 mol dm ⁻³ HCl

a.

i. The graph in Figure 2 shows the volume of carbon dioxide produced during the experiment using powdered barium carbonate. On the same axes sketch the graph that would be produced using barium carbonate in chunky form. (2)

This question continues on next page.

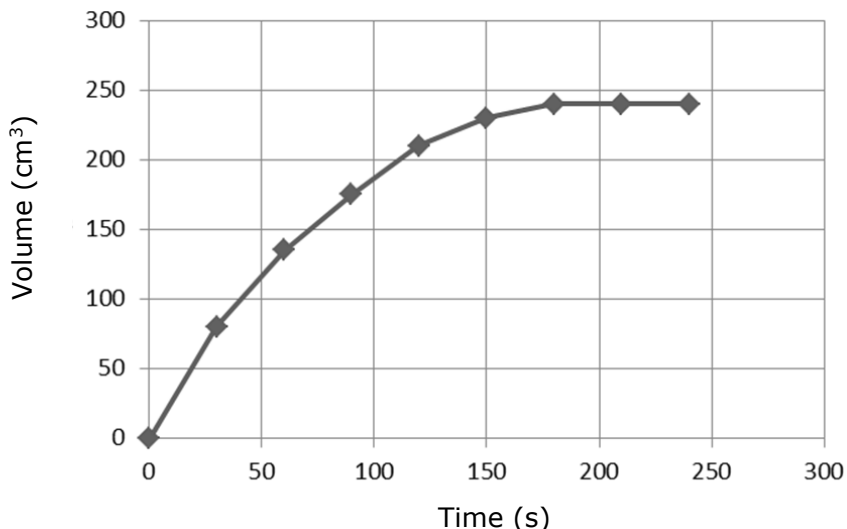


Figure 2

ii. Which reaction finishes first?

_____ (1)

b. Identify a condition that can make the reaction go faster.

_____ (1)

c. State why is it important that in the experiment there is only one variable.

_____ (1)

(Total: 5 marks)

11. This question deals with the heat of combustion of ethanol which has increased in popularity as a fuel in fireplaces.


a. State whether the combustion of ethanol exothermic or endothermic.


_____ (1)

b. Describe briefly how to carry out an experiment in the laboratory to find the heat of combustion of ethanol.

_____ (6)

(Total: 7 marks)

Reactivity series	
	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Hydrogen
	Copper
	Silver
	Gold
	Platinum

Order of discharge at cathode	
	Na ⁺
	Mg ²⁺
	Al ³⁺
	Zn ²⁺
	Fe ²⁺
	Pb ²⁺
	H ⁺
	Cu ²⁺
	Ag ⁺

Order of discharge at anode
1. For aqueous very dilute solutions OH ⁻ is discharged.
2. For aqueous concentrated solutions containing halide ions (Cl ⁻ , Br ⁻ and I ⁻), these are discharged in preference to OH ⁻ .
3. SO ₄ ²⁻ , NO ₃ ⁻ and CO ₃ ²⁻ are never discharged from aqueous solutions.

List of polyatomic ions and their charges.	
Name	Formula
Ammonium	NH ₄ ⁺
Nitrate	NO ₃ ⁻
Sulfate	SO ₄ ²⁻
Carbonate	CO ₃ ²⁻
Hydrogencarbonate	HCO ₃ ⁻
Hydroxide	OH ⁻

Solubility rules	
Soluble	Insoluble
<ul style="list-style-type: none"> All nitrates. All hydrogencarbonates. All group 1 metal salts. All ammonium salts. Halides except silver and lead halides. Sulfates except barium, calcium, and lead sulfates. 	<ul style="list-style-type: none"> Carbonates except group 1 metal and ammonium carbonate. Metal oxides except group 1 and 2 metal oxides that react with water. Hydroxides except group 1 metal and ammonium hydroxides.



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**SECONDARY EDUCATION CERTIFICATE LEVEL
2025 MAIN SESSION**

SUBJECT: **Chemistry**
 PAPER NUMBER: II – Level 1-2
 DATE: 22nd May 2025
 DURATION: 2 hours 5 minutes

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = $4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = $0 \text{ }^\circ\text{C}$ and 10^5 Pa /1 atm.

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Answer ALL questions.

1.

a. Name Group 1 and Group 7 of the Periodic Table.

Group 1: _____; Group 7: _____ (2)

b. Give **ONE** common use of chlorine.

_____ (1)

c. Give **ONE** common use of sodium hydrogencarbonate.

_____ (1)

d. Describe what happens to the boiling point of elements as one moves down Group 1.

_____ (1)

e. Describe what happens to the state of matter of the elements as one moves down Group 7.

_____ (1)

(Total: 6 marks)

2. Metals are found in nature or extracted from rock minerals.

a. Name the metal that is extracted from bauxite.

_____ (1)

b. Most extractions involve a series of chemical reactions. Mark the statements in Table 1 as true (T) or false (F). (3)

Table 1

Statement	True or False
Chemical reactions involve bond breaking and bond formation.	
The composition of the substances remains the same after a chemical reaction.	
No energy is needed or released during a chemical reaction.	

c. Underline the sentence that describes solids. (1)

- Take the shape of the container and have a fixed volume.
- Have a fixed shape and a fixed volume.
- Have no fixed shape and volume.

d. Give **ONE** method of how rusting can be prevented.

_____ (1)

e. Give **ONE** use of iron in everyday life.

_____ (1)

(Total: 7 marks)

3. Nitrogen is the main gas found in the Earth's atmosphere.

a. Describe a typical nitrogen atom.

_____ (1)

b. Draw a dot-cross diagram, showing **all** electron shells of a nitrogen atom.

_____ (2)

c. The atmosphere is made up of a mixture of different elements and compounds. Explain the difference between a mixture and a compound.

_____ (2)

d. Give the approximate percentage of nitrogen in the atmosphere.

_____ (1)

e. Nitrogen is used to replace air in food packaging to preserve the freshness and quality of food. Give **TWO** reasons.

_____ (2)

(Total: 8 marks)

4. Several chemicals were tested using different indicators.

a. Determine whether each substance (A to C) is acidic, alkaline, or neutral. Write your answer in Table 2 below. (3)

Table 2

Substance	Indicator used	Initial colour observed	Final colour observed	Acidic, Alkaline, Neutral
A	Universal indicator	Green	Purple	
B	Phenolphthalein	Colourless	Pink	
C	Methyl orange	Yellow	Red	

b. Identify an indicator from Table 2 that may be used to find the pH value of a substance.

_____ (1)

- c. The treatment of stings usually involves neutralisation with a weak acid like lemon juice or a weak alkali like dilute ammonia. This stops the pain. The information below was found on a sign at the beach.

...if you step on a sea urchin, treat the sting with a mixture of olive oil and lemon juice...

... a bee sting should be treated with ammonia...

Use the information given to indicate the pH of the stings of:

- i. sea urchins: _____ (1)
- ii. bees: _____ (1)
- (Total: 6 marks)**

5. Chemical changes can be reversible or irreversible.
- a. Fill in Table 3, using the terms in the word bank below, to best describe the reactions. (4)

Thermal decomposition	Precipitation
Combustion	Acid-base

Table 3

Reaction	Term
Magnesium oxide reacting with hydrochloric acid	
Magnesium being heated in air	
Magnesium hydroxide being heated strongly	
Magnesium nitrate solution reacting with sodium carbonate solution	

- b. All the reactions above are considered to be irreversible. Give **ONE** example of a reversible reaction.
- _____ (1)

- c. Give the symbol used to represent a reversible change.
- _____ (1)
- (Total: 6 marks)**

6. Some substances conduct electricity when connected to a DC circuit while others do not.
- a. Tick with a ✓ the appropriate box in Table 4 to indicate whether each of the following substances conducts electricity or **not** when connected to a DC circuit. (4)

Table 4

Substance	Conduct	Does not conduct
Seawater		
Copper(II) chloride crystals		
Copper		
Dilute copper(II) sulfate		

- b. Give a substance mentioned in part (a) which is a conductor but not an electrolyte. (1)
- _____
- c. Describe what happens at the anode and the cathode when electricity is passed through molten copper(II) chloride. (2)
- _____

(2)
(Total: 7 marks)

- 7.
- a. Fill in the blanks.
- i. Coal and crude oil are known as _____ fuels. (1)
- ii. Crude oil consists of a _____ of hydrocarbons. (1)
- iii. Hydrocarbons consist of carbon and _____ only. (1)
- b. Give the name of the process used to separate crude oil into different substances. (1)
- _____
- c. Crude oil and petrol are miscible liquids. Distinguish between miscible and immiscible liquids. (2)
- _____
- d. Islands that do **not** receive fuel via a pipeline rely on sea transport and must store the fuel on-site. Describe **ONE** advantage of this practice. (1)
- _____
- e. Describe **ONE** way in which the use of fossil fuels may lead to water pollution. (1)
- _____

This question continues on next page.

f. Give the name of the process by which the sulfur content in fossil fuels can be decreased.

_____ (1)

(Total: 9 marks)

8. Read the passage below and answer the questions that follow.

"In 2022, the Water Services Corporation (WSC) produced 35.5 million cubic meters of potable water to meet the water demand. The corporation achieved this by utilizing both Reverse Osmosis plants and groundwater production sites."

Reference: <https://www.wsc.com.mt/about-us/water-production-distribution/>

a. Give **ONE** source of potable water in Malta.

_____ (1)

b. Briefly describe the process of reverse osmosis.

_____ (3)

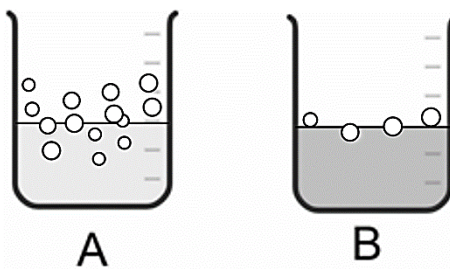
c. Groundwater in Malta is hard. Describe which **TWO** ions cause the water to be hard.

_____ (2)

d. Describe **TWO** disadvantages of water hardness.

_____ (2)

e. Two identical pieces of soap are added to two beakers, A and B shown in the diagram below. The beakers contain equal amounts of water but one contains hard water while the other contains soft water. Which of the beakers contains hard water?



_____ (1)

f. The ions that cause hardness are dissolved in water. Are these ions considered to be the solute or the solvent?

_____ (1)

- g. Give the name of the change of state that happens when water is heated in a beaker.

(1)

(Total: 11 marks)

9. Look at the organic molecules in Table 5 below and answer the following questions.

Table 5

$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ <p>A</p>	$\begin{array}{ccc} & & \text{H} \\ & & \\ \text{H}-\text{C}\equiv\text{C}-\text{C}-\text{H} \\ & & \\ & & \text{H} \end{array}$ <p>B</p>	$\begin{array}{ccc} \text{H} & \text{H} & \\ & & \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ & & \\ \text{H} & \text{H} & \end{array}$ <p>C</p>
$\begin{array}{ccc} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C}=\text{C}-\text{H} \end{array}$ <p>D</p>	$\begin{array}{ccc} \text{H} & \text{H} & \\ & & \\ \text{H}-\text{C}-\text{C}-\text{H} \\ & & \\ \text{H} & \text{H} & \end{array}$ <p>E</p>	$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{O} \\ & & & // \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C} & & & \\ & & & \backslash \\ \text{H} & \text{H} & \text{H} & \text{O}-\text{H} \end{array}$ <p>F</p>

- a. Using the letters of the organic molecules in Table 5, identify which molecules belong to each of the following homologous series. Each letter may be used once, more than once or not at all. Write **ONE** letter only for each homologous series listed below. (5)

Homologous series	Organic compound
Alkanes	
Alkenes	
Alkynes	
Alcohols	
Carboxylic acids	

- b. Which of the organic molecules A to F in Table 5 are unsaturated?

(2)

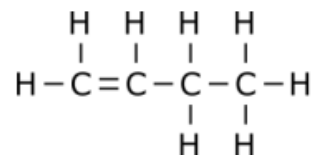
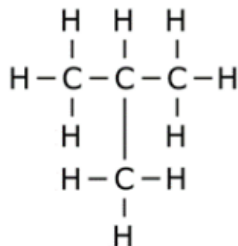
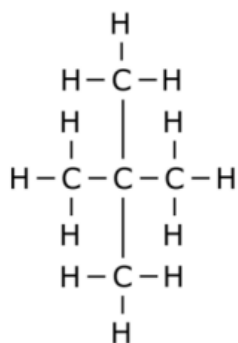
c.

- i. Define isomerism.

(1)

This question continues on next page.

- ii. Circle **ONE** of the structures below that represents an isomer of organic compound A. (1)



- d. Substance **D** can be used to make polyethene.

- i. Give **ONE** use of polyethene.

_____ (1)

- ii. Discuss a strategy that can be used to alleviate the environmental problems caused when polyethene is thrown away.

_____ (1)

- iii. Relate the burning of polyethene with the environmental problems that this creates.

_____ (1)

(Total: 12 marks)

10. A series of tests, including flame tests and tests for carbonates, are performed to identify unknown substances.

- a. Draw lines to match the metal cation and the colour of its flame test. (4)

Cation		Flame test
Sodium		Orange-red
Potassium		Red
Calcium		Lilac
Lithium		Golden yellow

- b. Fill in the passage below.

A test for the presence of the carbonate ion in an unknown substance involves reacting it with dilute _____. If carbonates are present, then _____ will be formed. This can be tested by bubbling it through _____ to see if it becomes milky. (3)

(Total: 7 marks)

11. The reaction of magnesium with hydrochloric acid is exothermic.

- a. Write a balanced chemical equation for the reaction between magnesium and dilute hydrochloric acid. Include state symbols.

_____ (3)

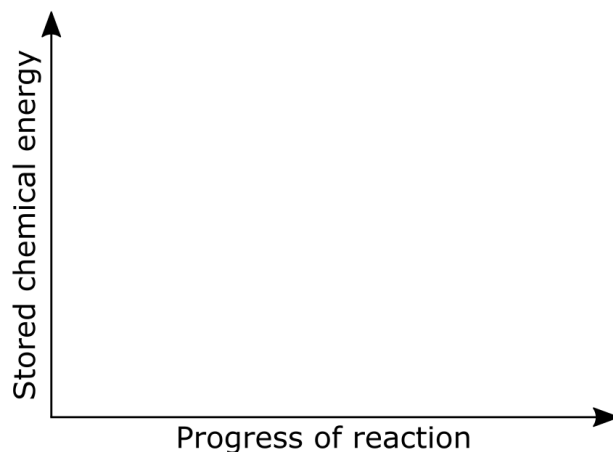
- b. State **TWO** conditions that can be used to increase the rate of reaction in part (a).

_____ (2)

- c. ΔH represents the heat change of a reaction. State whether the heat change of this reaction would be negative or positive.

_____ (1)

- d. Draw an energy level diagram to represent the reaction in part (a). Label the reactants, products, heat change, and activation energy. (5)



- e. Give **TWO** more examples of exothermic changes.

_____ (2)

(Total: 13 marks)

12. A 10 g sample of hydrated iron(II) sulfate, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$, is heated to remove its water of crystallization. After heating, the mass of the anhydrous iron(II) sulfate remaining is 5.5 g. RMM (H_2O) is 18.

- a. Calculate the RFM of iron(II) sulfate.

_____ (2)

- b. Find the mass of water present in the original sample of iron(II) sulfate.

_____ (1)

This question continues on next page.

c. Calculate the number of moles of iron(II) sulfate and water present in the sample.

(2)

d. Find the value of x in hydrated iron(II) sulfate.

(3)

(Total: 8 marks)

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	0
----------	----------	----------	----------	----------	----------	----------	----------


1	H Hydrogen 1						2	4 He Helium 2
----------	----------------------------------	--	--	--	--	--	----------	---


7	Li Lithium 3	9	Be Beryllium 4	11	Na Sodium 11	12	Mg Magnesium 12	13	Al Aluminium 13	14	Si Silicon 14	15	P Phosphorus 15	16	S Sulfur 16	17	Cl Chlorine 17	18	Ar Argon 18
19	K Potassium 19	20	Ca Calcium 20	21	Sc Scandium 21	22	Ti Titanium 22	23	V Vanadium 23	24	Cr Chromium 24	25	Mn Manganese 25	26	Fe Iron 26	27	Co Cobalt 27	28	Ni Nickel 28
37	Rb Rubidium 37	38	Sr Strontium 38	39	Y Yttrium 39	40	Zr Zirconium 40	41	Nb Niobium 41	42	Mo Molybdenum 42	43	Tc Technetium 43	44	Ru Ruthenium 44	45	Rh Rhodium 45	46	Pd Palladium 46
55	Cs Caesium 55	56	Ba Barium 56	57	La Lanthanum 57	72	Hf Hafnium 72	73	Ta Tantalum 73	74	W Tungsten 74	75	Re Rhenium 75	76	Os Osmium 76	77	Ir Iridium 77	78	Pt Platinum 78
85	Rb Rubidium 37	88	Sr Strontium 38	89	Y Yttrium 39	91	Zr Zirconium 40	93	Nb Niobium 41	96	Mo Molybdenum 42	99	Tc Technetium 43	101	Ru Ruthenium 44	103	Rh Rhodium 45	106	Pd Palladium 46
133	Cs Caesium 55	137	Ba Barium 56	139	La Lanthanum 57	178	Hf Hafnium 72	181	Ta Tantalum 73	184	W Tungsten 74	186	Re Rhenium 75	190	Os Osmium 76	192	Ir Iridium 77	195	Pt Platinum 78
131	Xe Xenon 54	127	I Iodine 53	122	Sb Antimony 51	119	Sn Tin 50	115	In Indium 49	112	Cd Cadmium 48	108	Ag Silver 47	106	Pd Palladium 46	103	Rh Rhodium 45	106	Pd Palladium 46
84	Kr Krypton 36	80	Br Bromine 35	75	As Arsenic 33	73	Ge Germanium 32	70	Ga Gallium 31	65	Zn Zinc 30	63.5	Cu Copper 29	59	Ni Nickel 28	59	Co Cobalt 27	59	Ni Nickel 28
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relative atomic mass
SYMBOL
Name
atomic number

$$\begin{matrix} a & & & & \\ & \mathbf{X} & & & \\ & & y & & \\ & & & & b \end{matrix}$$

Key:

Reactivity series	
	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Hydrogen
	Copper
	Silver
	Gold
	Platinum

Order of discharge at cathode	
	Na ⁺
	Mg ²⁺
	Al ³⁺
	Zn ²⁺
	Fe ²⁺
	Pb ²⁺
	H ⁺
	Cu ²⁺
	Ag ⁺

Order of discharge at anode
1. For aqueous very dilute solutions OH ⁻ is discharged.
2. For aqueous concentrated solutions containing halide ions (Cl ⁻ , Br ⁻ and I ⁻), these are discharged in preference to OH ⁻ .
3. SO ₄ ²⁻ , NO ₃ ⁻ and CO ₃ ²⁻ are never discharged from aqueous solutions.

List of polyatomic ions and their charges.	
Name	Formula
Ammonium	NH ₄ ⁺
Nitrate	NO ₃ ⁻
Sulfate	SO ₄ ²⁻
Carbonate	CO ₃ ²⁻
Hydrogencarbonate	HCO ₃ ⁻
Hydroxide	OH ⁻

Solubility rules	
Soluble	Insoluble
<ul style="list-style-type: none"> All nitrates. All hydrogencarbonates. All group 1 metal salts. All ammonium salts. Halides except silver and lead halides. Sulfates except barium, calcium, and lead sulfates. 	<ul style="list-style-type: none"> Carbonates except group 1 metal and ammonium carbonate. Metal oxides except group 1 and 2 metal oxides that react with water. Hydroxides except group 1 metal and ammonium hydroxides.



L-Università
ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2025 MAIN SESSION**

SUBJECT: **Chemistry**
 PAPER NUMBER: II – Level 2-3
 DATE: 22nd May 2025
 DURATION: 2 hours 5 minutes

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = $4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$

The molar volume for gases = 22.4 dm^3 at STP

STP conditions = $0 \text{ }^\circ\text{C}$ and 10^5 Pa /1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations, you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- The following information is printed on the back of this booklet:
 - Periodic Table.
 - Reactivity Series.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Score																
Maximum	8	8	7	4	8	9	5	7	8	8	4	10	4	4	6	100

Answer ALL questions.

1. Nitrogen is the main gas found in the Earth’s atmosphere.
 a. Describe a typical nitrogen atom.

_____ (1)

- b. Draw the dot-cross diagram, showing **all** electron shells of a nitrogen atom.

(2)

- c. The atmosphere is made up of a mixture of different elements and compounds. Explain the difference between a mixture and a compound.

 _____ (2)

- d. Give the approximate percentage of nitrogen in the atmosphere.

_____ (1)

- e. Nitrogen is used to replace air in food packaging to preserve the freshness and quality of food. Give **TWO** reasons.

 _____ (2)

(Total: 8 marks)

2. When rainwater falls through the air, it reacts with carbon dioxide and forms a weak acid.

- a. Name the weak acid formed.

_____ (1)

- b. Describe how water hardness is formed. In your description, name the metal ions present in hard water which cause limescale.

 _____ (2)

- c. Mark the statements in Table 1 as true (T) or false (F). (2)

Table 1

Statement	True/False
Hard water lathers (foams) easily with soap.	
Limescale buildup in pipes, boilers and kettles is caused by hard water.	

d. Water hardness can be permanent or temporary. Write an equation to show how boiling removes temporary hardness. Include state symbols.

_____ (3)
(Total: 8 marks)

3.

a. Litmus paper can be used to distinguish between acids and alkalis. State the colour change, if any, of moist red litmus paper when testing the following substances:

Lime water: _____ Lemon juice: _____ (2)

b. Some oxides are known as 'amphoteric'. Explain.

_____ (1)

c. Some students wanted to prepare a pure dry sample of barium sulfate. They add a solution of barium chloride to a solution of sodium sulfate.

i. Write a net ionic equation for the reaction which takes place. Include state symbols.

 _____ (3)

ii. The procedure followed by the students is listed below, but the steps are **not** in the correct order. In Table 2, write numbers 1 to 4 next to each statement to show the correct order of the procedure. (1)

Table 2

Statement	Number / Order
Wash with distilled water to remove unreacted substances.	
Filter to collect the precipitate on a filter paper.	
Allow the salt to dry in a sunny spot.	
Mix and stir the two solutions in a large beaker.	

(Total: 7 marks)

4. A student wants to carry out an experiment to determine which materials are conductors or insulators. The following materials are tested:

- graphite;
- glass;
- copper;
- wood.

a. Draw a labelled diagram of the setup which the student should use.

(2)

b. Define conductors and electrolytes.

_____ (2)

(Total: 4 marks)

5. This question is about the elements in the Periodic Table.

a. In what state do fluorine and chlorine occur at room temperature?

_____ (1)

b. A colour change occurs when chlorine gas is bubbled through a potassium bromide solution. However, if bromine is passed through potassium chloride solution **no** change is observed.

i. Write a net ionic equation for the reaction which occurs between chlorine and potassium bromide solution. Include state symbols.

_____ (3)

ii. Identify the element which is being reduced in the part (b) (i) and explain your answer in terms of electrons.

_____ (2)

c. Lithium and potassium both react with water. State which of these metals is the more reactive and explain your answer in terms of atomic structure.

_____ (2)

(Total: 8 marks)

6. This question is about using chemical tests to identify different compounds.

a. For each of the following pairs of substances, describe a chemical test which can be used to distinguish between them. Your answer should include the results of the test on both substances. Chemical equations are **not** needed.

i. Solutions of potassium sulfite and potassium sulfate.

_____ (3)

ii. Solutions of sodium chloride and sodium iodide.

_____ (3)

- b. A few drops of dilute sodium hydroxide solution are added to a sample of a greenish blue solution of X in a test tube. A blue precipitate which is insoluble in excess sodium hydroxide solution is observed. On adding aluminium powder and heating gently, a pungent colourless gas Y is given off. This gas turns damp red litmus paper blue. Identify solid X and gas Y.

Solid X is _____ (2)

Gas Y is _____ (1)

(Total: 9 marks)

7. Read the following paragraph and then answer the questions that follow.

Open quarrying of stone has significant economic and environmental impacts. However, the environmental costs are substantial. Quarrying disrupts ecosystems, leads to habitat destruction, and causes pollution. The landscape can be permanently scarred, and improper rehabilitation of quarries makes these issues worse.

- a. Give **ONE** benefit of the open quarrying of stone.

_____ (1)

- b. Explain **TWO** issues which describe the environmental impact of open quarrying of stone.

_____ (4)

(Total: 5 marks)

8. Iron is extracted in a blast furnace. A range of chemical reactions occur inside the blast furnace under specific conditions. The process involves the reduction of iron ore to iron by carbon monoxide. Limestone is also added to the furnace. The molten iron which comes out from the furnace is known as 'pig iron'.

- a. Write the equation for the reaction between iron(III) oxide and carbon monoxide.

_____ (2)

- b. In the process the carbon monoxide becomes carbon dioxide. State whether carbon monoxide is oxidized or reduced. Explain your answer in terms of oxidation numbers.

_____ (2)

This question continues on next page.

c. State what happens to iron in terms of electron transfer.

_____ (1)

d. Explain why limestone is added to the furnace.

_____ (1)

e. What is the name of the by-product formed in part (d)?

_____ (1)

(Total: 7 marks)

9. A 10 g sample of hydrated iron(II) sulfate, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$, is heated to remove its water of crystallization. After heating, the mass of the anhydrous iron(II) sulfate remaining is 5.5 g. RMM (H_2O) is 18.

a. Calculate the RFM of iron(II) sulfate.

_____ (2)

b. Find the mass of water present in the original sample of iron(II) sulfate.

_____ (1)

c. Calculate the number of moles of iron(II) sulfate and water present in the sample.

_____ (2)

d. Find the value of x in hydrated iron(II) sulfate.

_____ (3)

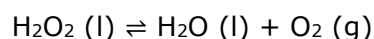
(Total: 8 marks)

10. Chemical reactions proceed at different rates.

a. Define the term 'rate of reaction'.

_____ (1)

b. A student wanted to investigate the effect of a catalyst on the rate of decomposition of hydrogen peroxide. The equation for the reaction is as follows:



The student was given two 50 cm³ samples of hydrogen peroxide and 10 g of powdered manganese(IV) oxide as the catalyst.

i. From the list below, underline **all** the apparatus that is **not** needed for this experiment. (2)

burette, conical flask, stop clock, delivery tubes, tap funnel, Bunsen burner, gas syringe, rubber bung
--

ii. Explain how the experiment should be carried out.

_____ (3)

iii. State the expected result of this experiment.

_____ (1)

iv. Mention another method apart from that in your answer to part (b) (ii) that could be used to measure the rate of reaction for this reaction.

_____ (1)

(Total: 8 marks)

11. This question is about the kinetic theory of matter.

a. When a liquid such as ethanol evaporates it changes into a gas. Use the kinetic theory to explain the energy changes which occur when ethanol becomes a gas.

_____ (2)

b. When gaseous butane is compressed at constant temperature it changes into a liquid, however liquid butane does **not** become a solid when it is compressed under the same conditions.

Interpret these observations in terms of the kinetic theory of matter.

_____ (2)

(Total: 4 marks)

12. Carbon can form different compounds.

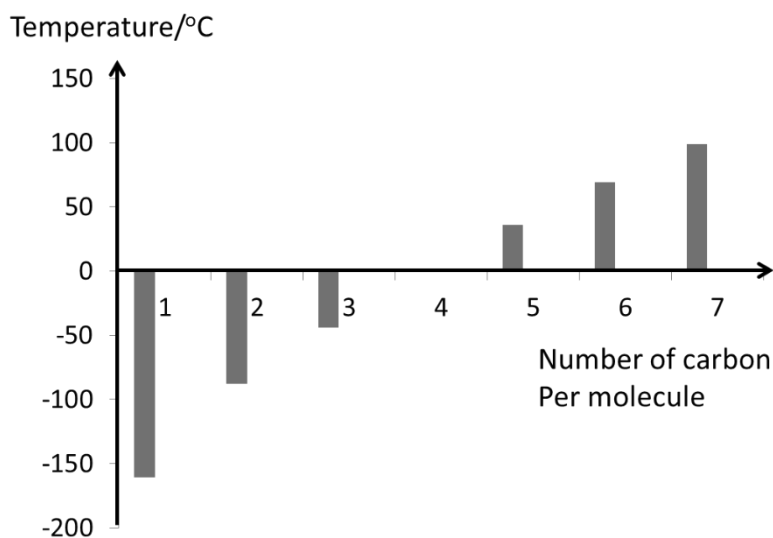
a. Give the general formula of alkanes.

_____ (1)

b. Draw the structures of the **TWO** isomers of C_4H_{10} .

_____ (2)

- c. The boiling points of some alkanes are shown in the following graph.



Source: <https://spmchemistry.blog.onlinetuition.com.my/2012/11/physical-properties-of-alkanes.html>

Use this graph to explain the trend of boiling points in alkanes.

_____ (2)

- d. Decane $C_{10}H_{22}$ is an alkane present in crude oil. It undergoes cracking to produce an alkane X which has seven carbon atoms in its molecule and another hydrocarbon Y.

i. Give the molecular formula of alkane X. _____ (1)

ii. Name hydrocarbon Y. _____ (1)

iii. Identify the functional group of hydrocarbon Y. _____ (1)

- iv. Decane is one of the compounds found in diesel which is a fossil fuel. Explain how the use of such fuels contributes to aerial and water pollution.

 _____ (2)

(Total: 10 marks)

13. In esterification an alcohol and a carboxylic acid react in the presence of a catalyst to produce an ester.

a. Write a chemical equation for the reaction between ethanol and ethanoic acid to produce an ester and water.

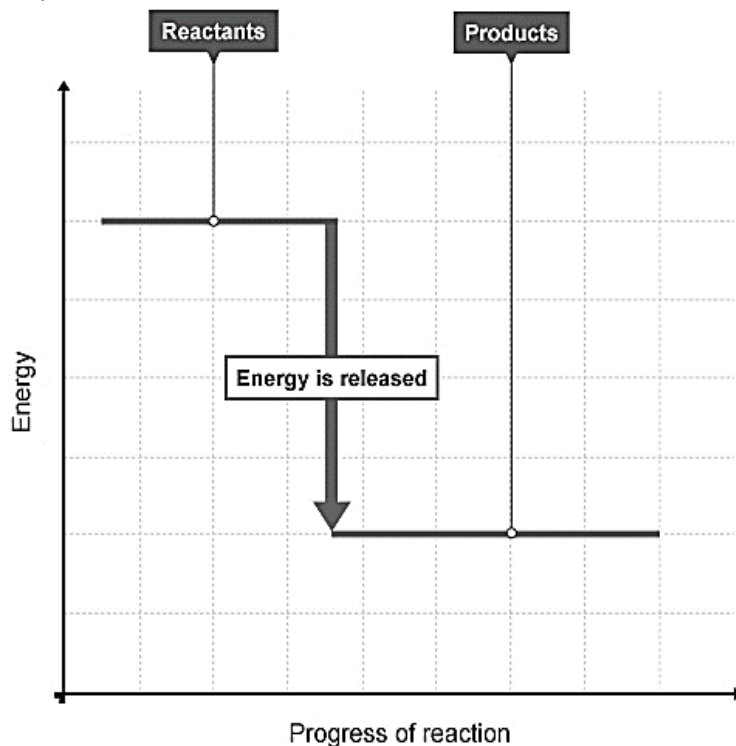
_____ (2)

- b. Draw the display formula of the ester formed in part (a) and identify the ester functional group by drawing a circle around it.

(2)

(Total: 4 marks)

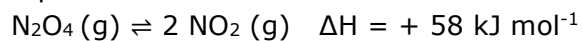
14. Energy level diagrams can be used to represent the energy changes that occur during a chemical reaction. Explain the following energy level diagram in terms of bond energies in the reactants and products.



Source: <https://www.bbc.co.uk/bitesize/guides/zg3vtv4/revision/1>

(Total: 4 marks)

15. Consider the following equilibrium reaction.



a. Identify a chemical product produced from nitrogen dioxide that is used as a fertiliser.

_____ (1)

b. N_2O_4 is colourless and NO_2 is brown.

i. State and explain what happens to the colour that would be observed when pressure is increased at constant temperature.

_____ (2)

ii. What colour change would be observed if the temperature is increased at constant pressure? Explain your answer.

_____ (3)

(Total: 6 marks)


PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	0																																																																																																																		
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">H Hydrogen 1</td> </tr> </table>	1	H Hydrogen 1	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">7</td> <td style="text-align: center;">Li Lithium 3</td> <td style="text-align: center;">9</td> <td style="text-align: center;">Be Beryllium 4</td> <td style="text-align: center;">23</td> <td style="text-align: center;">Na Sodium 11</td> <td style="text-align: center;">24</td> <td style="text-align: center;">Mg Magnesium 12</td> <td style="text-align: center;">39</td> <td style="text-align: center;">K Potassium 19</td> <td style="text-align: center;">40</td> <td style="text-align: center;">Ca Calcium 20</td> <td style="text-align: center;">85</td> <td style="text-align: center;">Rb Rubidium 37</td> <td style="text-align: center;">88</td> <td style="text-align: center;">Sr Strontium 38</td> <td style="text-align: center;">133</td> <td style="text-align: center;">Cs Caesium 55</td> </tr> </table>	7	Li Lithium 3	9	Be Beryllium 4	23	Na Sodium 11	24	Mg Magnesium 12	39	K Potassium 19	40	Ca Calcium 20	85	Rb Rubidium 37	88	Sr Strontium 38	133	Cs Caesium 55	<table border="1" style="width: 100%; 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Key:

a	X	y	b
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relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Hydrogen
	Copper
	Silver
	Gold
	Platinum